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# TRANSACTIONS

OF THE

## AMERICAN PHILOSOPHICAL SOCIETY.

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### ARTICLE I.

ON CALIFORNIAN MOSSES.

BY LEO LESQUEREUX.

Read June 19th, 1863.

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THE history of the Mosses or the Bryologia\* of the western shores of the North American continent, presents a peculiar anomaly: that of having been noticed by one of the earliest celebrated botanists of England, and of being, even at this time, scarcely known to the scientific world. Menzies collected specimens of mosses in California and Southern Oregon during his travelling explorations from 1787 to 1793. Some of the species were published by himself in the *Transactions of the Linnean Society*; others by Hooker in his *Muscologia Exotica*, and a few by Schwægrichen. The number of these species was quite small. In Müller's *Synopsis Muscorum*, which appeared in 1851, there are only fifteen species published and described from the western shores of North America.

The first important contribution to the Bryologia of California was made by Dr. Bigelow, botanist of a United States exploration from the Mississippi to the Pacific Ocean

\* I use this word in its general sense as representing the history of the mosses, either in their specific relation or in their local and geographical distribution.

under Lieutenant A. W. Whipple. The mosses there gathered by this excellent botanist were enumerated and described by Mr. W. S. Sullivant for the report of the explorations in 1856. Somewhat later, in 1859, a gentleman from Germany, Mr. T. Bauer collected mosses in a tour from San Francisco to the Sierra Nevada, and sent them to Hampe, who published a description of eleven species in a pamphlet prepared in 1860 for the Bot. Zeitung. Recently, a young botanist, Mr. Hy. Bolander, formerly of Columbus, Ohio, having taken up his residence at San Francisco, has given particular attention to the study of the Californian mosses, and in less than one year, has collected as many species as all the other collectors together. Mr. Bolander's contribution is rendered particularly interesting to bryological science, not only by the number of species, but by the great care manifested in collecting and preserving fine specimens in a perfect state of maturity, and in such abundance as to render examinations satisfactory, and also noting the time of maturity, the habitat, and all circumstances necessary to arrive at a correct knowledge of the species in all its phases.

He sent me by mail, almost weekly, examples of species new to science or new for California. Hampe's remarks about the Bryologia of the Sierra Nevada,—*that this country is still for mosses terra incognita*, is apparently applicable to the whole State of California. Nevertheless, the following enumeration of Mr. Bolander's mosses will show, as was already done by that of Dr. Bigelow's collection, that the conclusions of the celebrated German botanist cannot be taken in such a general way as he appears to have done, and that the species are by far not all new.

SPECIES OF MOSSES COLLECTED BY MR. HY. BOLANDER IN CALIFORNIA (1862 TO 1863).

1. *EPHEMERUM serratum* Hmp.

In a meadow near Mission-Dolores. March.

2. *ACAULON muticum* C. Mull.

Same place. March.

3. *PHASCUM cuspidatum* Schreb.

Same place. Var: *δ piliferum humile* Bryol. Eur. On the ground near Oakland, San Francisco. March.

4. *PLEURIDIUM subulatum* Bryol. Eur.

The calyptra has a longer point than the European form, which is the only difference. Wet ditches and dry hills, San Francisco. April.

5. *WEISIA viridula* Brid.

A very variable species. One of the Californian forms has the capsule somewhat longer

and more slender, pale green, marked, even before full maturity, with eight regular deep striae. The teeth are simple, shorter, irregular, variable in size. On the ground, San Francisco.

6. *WEISIA cirrhata* Hedw.

Appears abundant in California, and variable. A fine form sent with the normal one, is more compactly caespitose, with shorter leaves, longer teeth of the peristome often split at the summit and marked with stronger articulations. Grows on the stumps of *Sequoia viridis*, Redwood, &c., around San Francisco.

7. *DICRANUM varium* Brid.

On perpendicular sandstone rocks, constantly watered by a spring near the Bay of San Francisco. The watering has elongated the stems, rendering them more slender, and giving to this form a peculiar look, different from its common appearance. Nevertheless, anatomical examination does not show any modification of specific characters.

8. *CERATODON purpureus* Brid.

The common form and also a variety with white pedicels (var. *xanthopus* Sul. & Lesq. in Musci exsic. Amer. 1st edit.) On roots and stumps of *Sequoia viridis*, &c.

9. *FISSIDENS limbatus* Sul. Bot. of the Ex.

Wet, shady ground near San Francisco. May. Appears common.

10. *TRICHOSTOMUM tophaceum* Brid.

Wet rocks, Fort Point. This species shows on its peristome all the varieties indicated in the Bryologia Europea. Even a smaller form with shorter capsules and a dark green color of foliage, has the peristomal teeth generally short, obtuse, united in one in their whole length, presenting thus a peristome of sixteen short, somewhat irregular divisions, like that of some *Seligeria*. But even on the same specimens, this variety disappears, and some capsules have the divided teeth of a true *Trichostomum*.

11. *TRICHOSTOMUM flexipes* Bryol. Eur.

*Trichostomum crassinerve* Hampe, in pamphlet, 1860. Mr. Hampe has made of this a new species, separated by the smaller size of the plants, narrower leaves, thicker evanescent nerves, smaller areolation, and white peristomal teeth. Comparing Bolander's and Hampe's specimens with original specimens from Sardinia, I find them perfectly identical. The areolation is the same, the color of the peristome, as well as the size of the plant and of the leaves are variable. This year, Mr. Bolander sent from Marin County specimens twice as large as the European ones, all the leaves having an evanescent nerve. In this large variety, the pedicel of the capsule is perfectly straight, as it is often also in the common form. Grows on shady ground near Oakland, &c.; appears common in California.

12. *BARBULA vinealis* Brid.

Very common and variable around San Francisco; on rocks, boulders, and wet ditches near the bay. May. Var.  $\alpha$  has the ramification, form of leaves, &c., of *Barbula vinealis*; but the operculum and peristome of *Barbula flexifolia* Hmp. Var.  $\beta$  *flaccida* Bryol. Eur. has the capsule and operculum of *Barbula vinealis*, and the long-linear, lanceolate, canaliculate, open-reflexed, loosely-imbricated leaves of *Barbula flexifolia*. This variety is apparently the equivalent of *BARBULA elata* C. Müll. Same habitat as the normal form.

13. *BARBULA flexifolia* Hampe loc. cit.

The characters separating this species from *Barbula vinealis* are, 1st. The leaves crisped when dry, squarrose-reflexed when humected, with revolute margins. 2d. The somewhat narrower, dark red capsule, with a longer operculum. 3d. The longer and more twisted teeth of the peristome, and their red color. These last characters are unreliable, the teeth varying in color, and being more or less twisted even on the same specimens, according to the age of the capsule. The characters taken from the leaves are also unreliable, and as this moss covers the sand along the shores, and in the vicinity of boulders covered with *Barbula vinealis*, these differences, I think, may be ascribed to variations from change of habitat.

14. *BARBULA virescens* Sp. nov. Inflorescentia, ramificatione priori proxima, differt: Caule longiori, inferne bruneo, superne amœne pallide virescente; foliis longioribus e basi lanceolatis, margine usque ad apicem revolutis, undulatis, areolatione duplo laxiori, distincta, areolis ovalibus; perichætialibus apertis; operculo breviori, annulo latiori.

This species is intermediate between *Barbula flexifolia* Hmp. and *Barbula semitorta* Sul., two species already closely related. From the first it differs essentially by the areolation; from the second, by the revolute margin of the longer leaves, a longer and more twisted peristome, and a broader basilar membrane. On rocks, Redwood and Oakland, near San Francisco.

15. *BARBULA artocarpa* Spec. nov. Dioica, compacte cæspitosa. Caule gracili, brevi, subsimplici. Foliis inferioribus brevibus, e basi ovata lanceolatis, nervo valido percurrente brevi-subulatis; superioribus longioribus, longius lanceolatos ubulatis; Perichætialibus latioribus, basi amplexantibus superne coarctatis subulatis erectis; Areolatione foliorum compacta illæ *Barbula vinealis* simili; Capsula ovata cylindrica brevi gracili, ore coarctata, operculo longe rostrato subcurvato; Annulo simplici persistente lato; Peristomii dentibus gracilioribus, albidis, semel tortis.

Except for its pretty large annulus, this species would agree with *Barbula gracilis* Schw. which it exactly resembles by the ramification, the form of the leaves and of the capsule. It is also nearly related to *Barbula subfallax* C. Müll, which has also no annulus, and a shorter basilar membrane. Mount del Diablo, California.

It is, indeed, with some misgiving, that I add two new species to this group of *Barbulae* already too much divided. But I have no other alternative but to do it, or to recall as mere varieties a number of forms considered as species by other authors, and whose characters are of the same kind and no more definite.

16. *BARBULA convoluta Hedw.*

On rocks near San Francisco. May.

17. *BARBULA Wahliana Schultz.*

Clay soil, San Francisco.

18. *BARBULA Bolanderi Spec. nov.* Gregaria, dioica. Caule brevi simplici; vel fasciculatim comanteramoso; Foliis inferioribus brevibus apertis, superioribus dense in rossulam imbricatis reflexis lingulatis vel oblongis obtusis vel nervo crasso fusco percurrente brevi-apiculatis, margine medio reflexis, raro revolutis, quandoque planis; areolatione basilari quadrato-elongata laxa pellucida superne densa chlorophyllosa quadrata-polygona papillosa. Perichæcialibus internis brevioribus. Capsula in pedicello brevi rubello crasso, cylindrica erecta vel subcernua atro-sanguinea; operculo rostrato obtusiusculo. Peristomii dentibus gracilioribus tortilibus rubellis granulosis; membrana basilari angusta tessellato luteo-albida; annulo brevi simplici persistente. Planta mascula graciliori, femineis intermixta. Perigonialibus brevibus, e basi late ovata superne lanceolatis obtusis, antheridiis paucis paraphysibus que duplo longioribus apice inflatis.

A fine species allied to *Barbula marginata Bryol. Eur.* Rocks near the Bay of San Francisco. Abundant.

19. *BARBULA amplexa Spec. nov.* Gregaria, dioica, priori valde affinis. Caule simplici brevi; foliis laxe imbricatis apertis lingulatis longioribus mollibus obtusis nervo valido sub apice evanido instructis; areolatione basi laxa quadrato-elongata, superiori densiori polygona pellucida echlorophyllosa; Perichæcialibus internis binis elongatis, vaginulam arete amplectentibus, erectis apice tantum subito reflexis; Capsula in pedicello rubello brevi, cylindrica erecta breviori, colore pallide-viridi; operculo recto obtuso pallide rubello. Peristomio, annulo flore que masculo priori similibus.

This species is distinct from the former, especially by its soft leaves with empty areolation; by the long internal perichæcial leaves, erect and embracing the vaginula and the base of the pedicel, and only reflexed at the summit; by the shorter, smaller capsule and shorter lid of a different color. Near San Francisco. May.

20. *BARBULA muralis Hedw.*

A few specimens of this species were sent, mixed with *Barbula flexifolia Hmp.* labelled: On rocks near San Francisco.

21. *BARBULA laevipila Schw.*

The Californian species appears a reduced form of the European. It has shorter stems, shorter leaves, and a slender capsule. On clay soil in Mount Diablo. May.

22. *BARBULA ruralis* Hedw.

On rocks near Mission Dolores, Oakland, &c. Very common in California. May.

23. *BARBULA Müllerii* Bryol. Eur.

On rocks; less frequent than the former, and found in the mountains. Mount Diablo. May.

24. *BARBULA latifolia* Bryol. Eur.

On a fence-post near a creek three miles from San Rafael, Marin County. April, 1863.

25. *DESMATODON flavicans* Br. & Schmp.

On clay soil, San Francisco. Rare.

26. *DESMATODON nervosus* Br. & Schmp.

On the walls of an old Indian abode, and on clay soil; rare. It differs from the European form by the leaves being lingulate, a little more obtuse and shorter apiculate, and by the inflation of the strong nerve above the middle. This last character is not persistent.

27. *ANACALYPTA Starkeana* Bryol. Eur. var.  $\beta$  *brachyodus*. *Weisia affinis* Hook & Tayl.

Clay soil, San Francisco.

28. *TETRAPHIS pellucida* Hedw.

Rotten wood.

29. *ENCALYPTA vulgaris* L.

Monte del Diablo, on clay soil, fissure of rocks.

30. *ZYGODON Californicum* C. Müll. Mr. Müller has not seen the male plant of this species. Inflorescentia dioica; planta mascula in iisdem cæspitibus intermixta, femineis validiori sub floribus innovante ramosa; floribus masculinis pentaphyllis; perigonalibus externis duobus e basi dilatata longe linearibus internis brevibus concavis ovato-lanceolatis acutis, versus apicem dentatis nervo ultra medium evanido; antheridiis numerosis paraphysibus que brevibus paucis.

Grows on shaded rocks in a creek, near the road to a paper mill, Marin County. April, 1863.

31. *ORTHOTRICHUM Texanum* Sul.

The teeth of the peristome of this species are often separated by sixteen rudimentary fugacious cilioli. The inflorescence is monoecious and the male flowers axillary. On shaded stones near Oakland, San Francisco.

32. *ORTHOTRICHUM cylindrocarpum* Spec. nov. Orthotricho strangulato affine, differt; capsula longi-

colla longiori cylindrica graciliori emersa; operculo conico longiori; calyptra longiori fusco-lutea, capsulam fere totam tegente, valde pilosa; vaginula pilis longis dense oblecta; dentibus peristomii externi pallidis, ciliolis robustis *longioribus* albidis *articulatis*; flore masculo terminali.

The male flowers are generally at the top of a branch above the innovations, and not merely axillar. The dry, empty capsule is not contracted below the mouth. The ramification, leaves, and areolation are the same. Oakland, on trees, scarce.

33. *ORTHOTRICHUM Lyellii* Hook. var. foliis longioribus siccitate magis crispatis *Brid.*

The species is extremely variable, especially for the size of the leaves, sometimes covered with long papillæ, sometimes nearly smooth. It grows on granite rocks and on trees. The form growing on boulders has the leaves generally shorter, sometimes turned to one side, especially at the top of the branches. This form is apparently *Orthotrichum papillosum* *Hampe*. Our species has only rarely the confervoid filaments which cover the European form. It is common in California.

34. *ORTHOTRICHUM rivulare* *Turn.*

On a fence-post near a creek, Marin County, together with *Barbula latifolia* *Bryol. Eur.*

35. *SCHISTIDIUM confertum* *Bryol. Eur.* var. foliis brevi-piliferis, areolatione densiori, dentibus peristomii rubelli ultra medium superne valde irregulariter lacerato dentatis.

I have not seen the calyptra. This may be a distinct species. On metamorphic rocks, Mount Diablo. May.

36. *GRIMMIA Californica* *Sul.*

On granite boulders, Mission Dolores, &c. Common. April.

37. *GRIMMIA trichophylla* *Grev.*

On sandstone near Oakland. Among other varieties of this species, there is one with a dark green color, leaves with a shorter hairy point, or even obtuse without pellucid point, areolation more distinctly square at the base, and more compact-obscure above, which might be separated in a species. But these variations are apparently due to the habitat, and this variable species has been already too much divided. It grows on granite boulders near Presidio.

38. *GRIMMIA montana* *Bryol. Eur.*

It differs in nothing from the European form but by the dark green color of the plants. Monte del Diablo. April.



39. *GRIMMIA leucophaea* Grev.

A variety with the hair-point of the leaves more strongly dentate, and the teeth of the peristome more irregularly divided. On granite boulders; common.

40. *RACOMITRIUM canescens* Brid.

It is also a variety differing from the European form by a narrower areolation nearly continuous near the base of the leaves and not papillous; by the hairy pellucid point of the leaves, dentate only, but not rugulose; by the cylindrical-ovate capsule of a lighter color. The plants are generally stronger, and the leaves longer. This variety, by its areolation, bears to the normal form the same relation as this bears to the variety *ericoides* with more papillous and rugose leaves. On shaded rocks at the banks of a creek, Marin County. April.

41. *HEDWIGIA ciliata* Ehrh.

On stumps of *Sequoia viridis*, California. I have never seen this species growing on wood. There may have been a change of labels. This new habitat is remarkable indeed.

42. *BRAUNIA Californica* Spec. nov. Monoica, laxe cæspitosa, fusco-lutea. Caule primario subrepente valde diverse ramoso; ramis erectis gracilibus julaceis apice incrassatis duris, vel simplicibus vel irregulariter innovante ramosis, ramulis brevibus rarius flagelliferis; foliis in sicco appressis, humiditate apertis, ramorum apice subsecundis, e basi subdecurrente oblongo ovatis, apice brevi lanceolatis, pellucide acuminatis vel acumine longiori flexuoso lævi peliferis enerviis, margine versus basim superne que reflexis, medio revolutis; areolatione basilari elongata, alari quadrata, superiori ovato-polygona pulcherrime seriatim catenulata distincta, utraque pagina præcipue externa papillosa; Perichætalibus brevioribus lanceolatis-acutis raro pellucide brevi acuminatis; capsula in pedicello semipolicari pallide luteo sinistrorsum torto, turbinata ore dilatata nuda; operculo conico-elongato obtuso recto.

By the general appearance and color of the stems, this species resembles the slender form of *Hedwigia ciliata*, the leaves being always terminated by a diaphanous, sometimes very long hairy point. The straight hard branches are variable in thickness, generally inflated at the innovations, and below the short flowers bearing branches. The male flowers, like the female, are at the top of one of these branches. Their many-leaved floral envelope has oval, short, pointed leaves, the point also diaphanous. As in the other species of this genus, the vaginula is very long, descending to the base of the fruit-bearing branch. The capsule, of a light brown color, is, when deoperculated, exactly top-shaped, broad-mouthed. The dark yellow calyptra split on one side is long, and incloses the whole capsule till its maturity. Grows in large patches on metamorphized rocks in Mount Diablo, up to 3000 feet. April, 1863.

43. *ATRICHUM undulatum* Beauv.

Santa Cruz Mountain, 4000 feet. Prof. Brewer, legit.

44. *POLYTRICHUM juniperinum* Hedw.

Rocks, Mission Dolores, &c.

45. *AULACOMNIUM androgynum* Schw.

On my Californian specimens, the male flowers are disciform as Bridel indicates it, and not gemmiform as is generally the case in the European specimens. The brown antheridia and filiform paraphyses are very numerous. On old logs of *Sequoia viridis*; appears to be common in California. April.

46. *BRYUM Tozzeri* Grev.

Deep shaded ditches near San Francisco.

47. *BRYUM Wahlenbergii* Schw.

Wet rocks, San Francisco. May.

48. *BRYUM Billardierii* Schw.

Deep Cañon, Mount Diablo. May.

49. *BRYUM Californicum* Sul.

In its full development, the cilioli of the internal peristome are long, mostly two together, and appendiculate. Common in the hills of Oakland on ground, in meadows near shrubs. April.

50. *BRYUM occidentale* Sul.

Like its near relative *Bryum caespitium*, this species is very variable. The ramification is from below and around the first fruit-bearing bud. The branches more or less numerous, nearly naked below, are either short, bearing at the top a thick bud of closely imbricated, short ovate, pointed, concave leaves; or, on sandy wet soil, become elongated, flagelliform, bearing distant, lanceolate, narrow, pointed leaves. The color of the capsule is as variable as its size. It is more generally blood red, but in the shade, it is either buff colored, or even greenish or variegated, half red, half brown. On sandy soil and rocks near the Bay of San Francisco.

51. *MNIUM insigne* Mitt.

In woods, Oakland. Sterile.

52. *MNIUM Menziesii* C. Müll.

Shaded banks of a creek, Marin County. April, 1863.

53. *BARTRAMIA stricta* Brid.

Differs only from the normal form by the pedicel *round-oval* at the top, and not square. On rather wet rocks, Mission Dolores.

54. *BARTRAMIA Menziesii* Turn.

*GLYPHOCARPA Baueri* Hampe in pamphlet, 1860. Dioica, laxa, late, cæspitosa; Caule elongato, bi-tripollicari et ultra, simplici vel parce innovante ramoso, e basi folioso, usque ultra medium tomentoso radiculoso brunneo, superne amœne viridi; Foliis undique appressis vel subapertis, humiditate erecto-apertis, e basi cava plicata margine reflexa ovato-lanceolata, superne lanceolato subulatis, margine dentatis, dorso nervoque valido in subulam exeunte scabris; Perichætalibus longioribus vix latioribus conformibus; Areolatione foliorum basi quadrato-minori distincta, superne longiori obscura papillosa; Theca in pedicello innovando laterali semipollicari pallide rubello vel stramineo sinistrorsum torto, ovali erecta regulari lævi pallide rufescente vel viridi; ore nuda, membrana simplici tantum circumdata; vel membrana irregulariter laciniata sub vel semi-peristomata; vel dentibus 16 lanceolatis, irregulariter articulatis fusco-rubellis haud vel cum linea mediali notatis simpliciter sed perfecte peristomata; Planta mascula sic et fæminea innovando-laterali vel terminali gemmacea; Foliis perigonalibus basi ovatis subito longe subulatis scabris; antheridiis elongatis curvatis fusco luteis paraphysibusque numerosis.

This species is evidently the one described by Turner, and collected by Menzies in California in 1792, as shown by original specimens preserved in Taylor's herbarium, and kindly furnished to me for comparison by Mr. Wm. S. Sullivant. The above-described modifications of the peristome would at first lead to the belief that there are two different species, the one without, the other with a simple peristome. But on the same specimen, I have found some capsules with a simple peristome of sixteen irregular, brown-reddish teeth; others with the pellucid peristomatal membrane, either simple and entire, or broken in short laciniae without definite shape, and more or less united together, or with the same membrane divided into sixteen laciniae already taking the shape of irregular teeth, but still preserving the pellucid tissue of the membrane. It is therefore evident that some peculiar influence, causing a more or less perfect development of the plant, is the only reason of the difference. The oval form of the capsules is more or less elongated, sometimes nearly round; except this all the characters are perfectly alike. This remarkable variation in the peristome exemplifies the value of Schimper's assertion in the *Bryologia Europea*; that little reliance can be put on the peristome of the *Bartramiae* to found generic divisions. We have here both the genera *Glyphocarpus* Brid. and *Bartramia* Auct. united in the same species.

According to Mr. Bolander, this *Bartramia* is very common in California, growing on rocks, Mission Dolores, Marin County, Mount Diablo, &c.

55. *FUNARIA Muhlenbergii* Schw.

Deep Cañon, Mount Diablo.

56. *ENTHOSTODON Bolanderi* Sp. nov. *Enthostodonte Templetoni* simile differt: foliis longius acuminatis, laxius areolatis, nervo vix medio ascendente; Capsulae collo longiori, basi subinflato, capsulaque propria breviori ovato-turbinata; operculo longiori, umbonato vel convexo obtuso apiculato; peristomii dentibus integris articulatis (nec nodosis); Foliis perigonalibus enervibus. *Enthostodonti commutato* Müll. quoque proximum

differt: foliis versus apicem subdentatis (nec integerrimis) peristomiique dentibus tantum articulatis (nec nodosis, nec linea media exaratis).

Wet rocks near the Bay of San Francisco. April.

57. *PHYSCOMITRIUM pyriforme* Brid.

On swampy ground, Marin County. April. Scarcely ripe.

58. *FONTINALIS Californica* Sul. Bot. of the Ex.

In a willow swamp near San Rafael. April.

59. *ANTITRICHIA Californica* Sul. MSS. *Antitrichiæ curti pendulæ proxima* differt: ramis brevioribus julaceis filiformibus ve; foliis in sicco arcte compressis, brevius acuminatis vix dentatis, areolatione densiori; capsula cylindrica longiore rubella; pedicello brevior recto; peristomii dentibus laxius et obscure articulatis; sporis duplo minoribus; perichætialiis longius lanceolato-acuminatis dentatis; vaginula crassiore.

On oak trees near San Francisco. Mr. Sullivant, in Botany of Whipple's Expedition, considered this species as different; but the specimens of the Expedition were without fruit, and thus it could not be exactly determined.

60. *FABRONIA pusilla* Raddi.

On oak trees, San Francisco.

61. *PTEROGONIUM gracile* Hedw.

*Leptohymenium duplicato-serratum* Hmp.

Mr. Hampe has made a new species of our Californian moss; but after a close examination of a large number of specimens, I do not find any difference between the European species and ours, except perhaps a little larger annulus for this last. The character taken from the size of the plant is unreliable; some Californian specimens being larger than any of those which I have from Europe, and the serrature of the leaves appears just the same in both forms. On rocks near the Bay of San Francisco. Common.

62. *ALSIA circinata* Sul. *Icones Musc.* tab. 72<sup>b</sup> ined.

*Leptodon circinatus* Sul. in Whipple's Expedition.

Dr. Bigelow's collection had only male plants of this species, which by leaves and ramification is closely allied to the genus *Leptodon*. Mr. Bolander has collected it with ripe capsules, and the peristome shows the species to be a true *Alsia*. On oak trees near San Francisco.

63. *ALSIA Californica* Sul.

On trees, rocks, &c. Common.

64. *HYPNUM crispifolium* Hook. *Musc. exot.*

*Hypnum* (*Thuidium*) *ramulosum* Hampe in litt. C. Müll.

Though Hooker's figure and description of this species are not satisfactory, the essential

characters of his species agree well with Müller's description, and also with our specimens. It is remarkable enough by its granular areolation (areolis reticuli minutissimis Hook.), its whitish or nearly pellucid nerve (nervo pallido sæpe sub pellucido Hook.), the long dentate flexuous acumen of the leaves (folia ramea omnia longe acuminata quandoque pilo flexuoso terminata Hook.), its short, rough, red pedicel (seta uncialis rubra tuberculosa Hook.) &c. Mr. Hooker even mentions the split teeth of the internal peristome resembling that of a *Bartramia*, and the general resemblance of the moss in some points with *Hypnum abietinum*. Müller's description of *Hypnum ramulosum* agrees perfectly and in every point with our specimens. On shaded rocks near the Paper Mill, Marin County.

65. *HYPNUM* (RHYNOSTEGIUM) *rusciforme* *Weis.*

Spring in a cañon near San Francisco.

66. *HYPNUM* (THAMNIUM) *Bigelowii* *Sul.*

On the bark of trees and on the ground. Very variable in size.

67. *HYPNUM* (EURYNCHIUM) *Stokesii* *Bryol. Eur.*

On the ground in the shade. Common.

68. *HYPNUM* (EURYNCHIUM) *Whippleanum* *Sul.* Bot. of the Ex.

Specimens of this species found mixed with *Fissidens limbatus* in Mr. Bolander's collection, show that the pedicel is sometimes smooth. On shady ground near San Francisco.

69. *HYPNUM* (EURYNCHIUM) *Oreganum* *Sul.*

On shaded old logs in a creek, Marin County.

70. *HYPNUM* (ISOTHECIUM) *Brewerianum* *Spec. nov.* *Hypno myosuroidi* per affine differt: colore sordide-luteo viridi, cæspitibus densioribus, ramis crassioribus, subjulaceis, raro elongatis filiformibus; foliis arcte imbricatis appressis, versus basim latioribus, superne subito in acumine brevi contractis, valde concavis vix denticulatis. Perichætalibus longius lanceolato subulatis reflexis; capsula cylindrica brevior rufa.

This species could be considered as *Hypnum stoloniferum* *Hook.*, but that this last species has, according to Hooker, drooping capsules and plants of a larger size. Hooker's plant was collected by Menzies on the roots of trees, even pending from branches. Ours, according to Mr. Bolander's remarks, grows on granite rocks near Mission Dolores. It was also collected by Professor Brewer of the Californian State Geological Survey, and is dedicated to him.

71. *HYPNUM* (BRACHYTHECIUM) *Bolanderi* *Spec. nov.* Dioicum laxè lateque cæspitosum pallide amœne viride. Caule diverse ramoso, ramis elongatis flexuosis, vel suberectis rigidis sub pinnatim vage ramosis; Foliis undique imbricatis apertis, ovato-lanceolatis breviter acuminatis margine plano undique serrulatis, nervo ultra

medio instructis; areolatione laxiori, cellulis angustis pellucidis, alaribus parum numerosis distinctis ovato-quadratis pellucidis; Perichætalibus e basi lata vaginantibus pellucide laxè elongate reticulatis subito fere in acumine flexuoso vel subreflexo attenuatis obsolete nervosis; Theca in pedunculo brevi semipollicari rugoso sanguineo, gibboso-ovali; annulo lato composito revolubili, operculo conico-acuto brevi; peristomii interni dentibus hyantibus, ciliis binis gracillimis separatis.

Ab *Hypno Sullivantii Spruce*, proximo differt: areolatione foliorum laxiore; cellulis alaribus majoribus quadratis distinctis: foliis margine planis; annulo latiori revolubili; operculo conico brevi, &c.

On the ground in the shade of *Oreodaphne Californica*. April.

72. *HYPNUM (SCLEROPodium) illecebrum Bryol. Eur.*

On rocks and on the ground, San Francisco, Oakland.

73. *HYPNUM (SCLEROPodium) caespitosum Bryol. Eur.*

On the ground among shrubs, &c., near San Francisco.

74. *HYPNUM (SCLEROPodium) Californicum Spec. nov.* Dioicum, laxè intricato-cæspitosum. Caule serpente vage ramoso; ramis longioribus filiformibus radicanibus; foliis laxè imbricatis apertis, ovato-lanceolatis acuminatis concavis integris vel vix serrulatis, nervo valido sub acumine evanido instructis; areolatione angustata elongata, cellulis alaribus numerosis, ovato-quadratis distinctis plus minusve granulosis; Perichætalibus late ovato-amplexantibus superne lanceolatis longè piliformi acuminatis, internis erectis, externis acumine reflexis; capsula in pedicello elongato gracili torto superne tantum papilloso rubello, inferne stramineo lævi, ovata-cylindrica brevi, pallide viridi cernua sub ore subconstricta, vacua erecta equali; late composite annulata; Operculo pallido conico acutiusculo lato; Peristomii externi dentibus sanguineis, interni ciliis luteis pertusis, ciliolis singulis vel binis robustis articulatis separatis. Floræ masculæ antheridiis robustis numerosis paraphysatis; foliis perigonalibus late-ovatis brevi-acuminatis integris.

On rocks and dry sand near the Bay of San Francisco.

75. *HYPNUM (CAMPTOTHECIUM) arenarium Spec. nov.* Dioicum, laxè lateque cæspitosum. Caule intricato suberecto parce vageque ramoso; ramis secundariis vel brevibus erectis subcurvatis utrinque attenuatis, vel longioribus filiformibus radicanibus. Foliis confertis undique imbricatis erectis subappressis, lanceolatis acuminatis striatis, margine reflexo subserrulatis, plicaturæ marginalis basi utrinque cavis, nervo valido sub acumine evanido instructis, dense angustè areolatis, cellulis alaribus numerosis basim integram folii efficientibus, ovato-rotundatis minimis vix distinctis; Perichætii elongati foliis externis brevioribus late-ovato acuminatis reflexis, superioribus amplexantibus subito in acumine piliformi erecto vel reflexo serrulato terminatis, margine superne eroso parce grosse dentatis, areolatione laxa basi quadrata polygonæ superne elongata pellucida; Foliis perigonalibus brevibus late-ovatis brevi acuminatis vel acutis integris nervosis, areolatione pellucida; Capsula in pedicello elongato gracili basi papilloso rugoso superne sublævi, parva ovato-cylindrica cernua; Operculo magno conico obtuso apiculato; Processus interni ciliis pertusis, ciliolis binis vel singulis brevibus fugacissimis separatis; Annulo composito lato persistente.

Ab *Hypno lutescente Hedw.* cui proximum, primo intuitu forma graciliori, capsula cernua brevi, &c., differt.

Covering sand around bushes near San Francisco.

76. *HYPNUM Nuttallii Wills. Bryol. Brit.*

*Leskea Californica Hampe.* Pamphlet, 1860.

This fine species is a true *Camptothecium* related to *Camptothecium aureum*

*Lag.*, and easily distinguished from any other species. On the bark of oak trees, common in California.

77. *HYPNUM* (*AMBLYSTEGIUM*) *serpens* *L.*

In a swamp at the foot of the Oakland Redwood Hills. March.

78. *HYPNUM subimponens* *Spec. nov.* *Hypno imponente* primo intuitu similimum differt: Foliis caulinis integris vel raro summo acumine subserrulatis; cellulis alaribus vel nullis vel perpaucis minoribus; areolatione densiori; foliis perichætalibus brevi-acuminatis erectis appressis integris; capsula graciliori cernua; operculo conico-obtuso; peristomii interni ciliis singulis vel binis longis gracilimis; annulo composito lato revolubili; vaginula nuda.

Shaded rocks in a creek, Marin County.

79. *HYPNUM riparium* *S.*

In a willow swamp, Marin County, &c.

Though we do not know probably one-half of the species of mosses inhabiting California, the materials on hand are already sufficient to permit us an inquiring look into the general character and the geographical distribution of the Bryologia of that country.

Mr. W. S. Sullivant's examination of the mosses collected in California by Dr. Bigelow, has enumerated sixty-four species, thirty of which have not yet been found by Mr. Boler. Menzies, Hooker, Hampe, Müller, and other authors have mentioned eighteen species from the west coast of North America, twelve of which are also not in Mr. Boler's collection. This gives us an amount of one hundred and twenty-one species of mosses now known in California. Of these, forty-two appear peculiar to Western North America, some of them ascending higher north in Oregon, but their northern range is still undetermined. Forty-two species are common to California, Eastern North America, and Europe; thirty-four are found in California and Europe, but not in Eastern North America, and none are common to California and Eastern North America solely. Three species have a range going somewhat out of this division, *Orthotrichum Texanum* and *Hypnum Nuttallii* appear to be species of a warmer climate; the first being found in Mexico, the second in Western Texas. - *Trichostomum corniculatum* Schw. goes as high north as Kamtschatka.

The species common to California, Europe, and Eastern North America, are mostly wandering or universal species, found nearly over the whole world in a temperate zone: some *Phascaceæ*, *Gymnostomum curvirostrum*, *Weisia viridula*, *Dicranum virens*, *Ceratodon purpureus*, *Tetraphis pellucida*, *Hedwigia ciliata*, &c., &c. On the contrary, those common only to California and Europe, and wanting in Eastern North America, are typical forms: species of *Trichostomum*, *Barbula*, *Desmatodon*, *Anacalypta*, *Zygodon*, *Braunia*, *Bryum*, *Hypnum*, especially of the section *Scleropodium* and *Camptothecium*. This at once already

shows the relation of the Bryological flora of California with that of Europe, and at the same time its entire disruption from that of Eastern North America. But the relation between the mosses of California and of Europe, is rendered still more remarkable by the identity of the peculiar habitat of some species, and at the same time by the near affinity of species which we consider as true Californian, with typical European forms. Thus on one side, Mr. Bolander finds *Desmatodon nervosus* on the walls of an old Indian abode, and Schimper found it first on the old walls surrounding Strasbourg. *Barbula latifolia* and *Orthotrichum urnigerum*, both species very rare in Europe, grow sometimes together on the stumps of old willow trees, or on old logs near running water, and Mr. Bolander finds them in California both together on an old fence-post in a creek. *Anacalypta Starkeana* and *Trichostomum flexipes* have in California also just the same habitat that both have in Sardinia, Smyrna, and other places on the shores of the Mediterranean Sea: for it is especially with the Mediterranean shores that California is related by its mosses. On another side, and considering the affinity of peculiar Californian species with European types, we find *Barbula vinealis* pertaining to Europe and California, and here six or seven species described as new, but so nearly related to the normal form that they might be considered as varieties only. *Barbula marginata*, a peculiar type found all around the Mediterranean Sea, in Spain, South France, Algeria, &c., is in California, with two peculiar or new species also very nearly related to it. The species of *Grimmia* and of *Bryum* present in California the same subdivision of forms, and the same relation of new species with European types. In the section *Scleropodium* of the genus *Hypnum*, we find in California with the two European species, a third one of a diminutive size but of the same affinity, and in the section *Camptothecium*, California has a species nearly allied to *Hypnum lutescens* of Europe, having precisely the same and peculiar habitat, viz., covering the sand around bushes. Even the fine new *Braunia*, the Californian representative of a genus whose species are very rare, is related more perhaps with *Braunia secunda* Müll. of the barren mountains of Mexico, but nearly also with *Braunia sciuroides* Bryol. Eur., a very rare plant of the southern valleys of Switzerland.

Is it possible to explain this remarkable analogy between the Bryologia of California and that of Southern Europe, by some law of transmission of species between intermediate points as that which apparently governs the distribution of the phænogamous plants? As the disruption eastward through Eastern North America is complete, we can only, to solve the question, look westward, in Japan and the adjacent islands, and see if we find there some link of connection.

Of the Bryology of Japan, we know nearly as much as of that of California, especially from the researches and collections of Mr. Charles Wright. Now we find, according to



data published formerly,\* that of eighty-six species gathered in Japan, thirty-three are proper to that country and described as new ; eight are exclusively common to Japan and Eastern North America, six to Japan and Europe, thirty-one to Japan, Europe, and Eastern North America, seven to Japan, Europe, Eastern and Western North America, and two only common to Japan, Europe, and Western North America. From this it is also evident that there is no connection whatever westward between the Bryologia of Europe and that of California ; that this last stands thus entirely isolated, and that to explain its relation with the flora of Southern Europe, we have to look for another cause of distribution than that of a transmission of species through intermediate points. This research is worth making, and to render it more interesting and at the same time more conclusive, the best way, I think, is to present in a tabular arrangement the number of species of each genus inhabiting the eastern and the western side of North America, compared with the number of species of the same genera found in Europe.

Counting all the species of mosses now known as belonging to Eastern North America, including Drummond's mosses, and those which have been found as far west as the Rocky Mountains, exclusively of those of Western North America, I find four hundred and ninety-three species. Perhaps a few more not yet recorded, have been found recently by Mr. Thomas P. James, or other American bryologists. Thus the round number five hundred would be reliable enough. Their distribution according to genera is as follows:

\* Characters of some new Musci collected by Charles Wright in the North Pacific Exploring Expedition under the command of Captain John Rodgers by William S. Sullivant and Leo Lesquereux (pamp., 1859).

Whole number of species in each genus.		Exclusively E. N. Amer.	Europe and E. N. Amer.	Also in California.	Whole number of species in each genus.		Exclusively E. N. Amer.	Europe and E. N. Amer.	Also in California.
No. 1, 16	Sphagnum, . . .	8	8		No. 21, 1	Conomitrium, . .		1	
2, 3	Andræa, . . .		3		22, 13	Fissidens, . . .	8	5	
3, 1	Archidium, . . .	1			23, 9	Trichostomum, . .	2	7	
4, 18	Phascum, . . .	7	11	4	24, 13	Barbula, . . .		13	3
5, 5	Bruchia, . . .	5			25, 7	Desmatodon, . .	3	4	1§
6, 1	Hymenostomum,* .		1		26, 1	Anacalypta, . . .		1	
7, 3	Gymnostomum, .		3	2	27, 4	Didymodon, . . .		4	
8, 2	Weisia, . . .		2	1	28, 2	Dystichium, . .		2	
9, 2	Rhabdoweisia, . .		2		29, 1	Eustichium, . .		1	
10, 1	Blindia, . . .		1		30, 4	Pottia, . . .		4	1
11, 3	Seligeria, . . .		3		31, 1	Tetraphis, . . .		1	1
12, 1	Arctoa, . . .		1		32, 1	Tetrodontium, . .		1	
13, 1	Campylostelium,† .		1		33, 6	Encalypta, . . .		6	1
14, 5	Campylopus,‡ . .	4	1		34, 1	Syrrhopodon, . .	1		
15, 1	Dicranodontium, .		1		35, 3	Zygodon,¶ . . .	1	2	
16, 2	Trematodon, . .	1	1		36, 1	Drummondia, . .	1		
17, 1	Angstroemia, . .		1		37, 20	Orthotrichum, . .	6	14	2
18, 30	Dicranum, . . .	3	27	1	38, 1	Macromitrium, . .	1		
19, 1	Ceratodon, . . .		1	1	39, 1	Schlotheimia,** .	1		
20, 2	Leucobryum, . .	1	1		40, 2	Ptychomitrium, .	2		

\* *Hymenostomum microstomum* ranges from Massachusetts to the base of the Rocky Mountains. It was collected by Drummond, and also by Mr. E. Hall, in a recent tour of botanical exploration with Dr. Parry, 1862.

† The very rare and beautiful *Campylostelium saxicola* Bryol. Eur. was discovered this year by Mr. R. C. Ingraham, of New Bedford, Mass., on boulders of granite.

‡ I could add three apparently new species of this genus, brought from the Rocky Mountains by Mr. E. Hall; but all these species are without fruit, and an exact determination of them is of course impossible.

§ *Desmatodon flavicans* ranges westward from the Rocky Mountains.

|| *Pottia subsessilis* ranges westward from Illinois. (E. Hall.)

¶ *Zygodon Sullivantii* Müll. It has never been found in fruit, and is thus a species of doubtful affinity.

\*\* The species of this genus, and also of *Macromitrium* and *Syrrhopodon* are tropical. Each of them has still one representative in Eastern North America.

Whole number of species in each genus.			Exclusively E. N. Amer.	Europe and E. N. Amer.	Also in California.	Whole number of species in each genus.			Exclusively E. N. Amer.	Europe and E. N. Amer.	Also in California.
No. 41,	5	Schistidium, . . .	2	3	2	No. 62,	4	Physcomitrium,§ .	1	3	1
42,	9	Grimmia, . . .	3	6	3	63,	1	Aphanorhegma, .	1		
43,	1	Coscinodon, . . .	1			64,	14	Splachnum, . . .	1	13	
44,	7	Racomitrium, . .		7	1	65,	10	Fontinalis, . . .	3	7	
45,	1	Hedwigia, . . .		1	1	66,	4	Dichelyma, . . .	2	2	
46,	1	Buxbaumia, . .		1		67,	3	Cryphæa, . . .	3		
47,	1	Diphyscium, . .		1		68,	2	Leucodon, . . .	2		
48,	3	Atrichum, . . .	1	2	1	69,	3	Leptodon, . . .	3		
49,	5	Pogonatum, . . .	3	2		70,	1	Antitrichia, . . .		1	
50,	6	Polytrichum, . .		6	2	71,	7	Anomodon, . . .	3	4	
51,	2	Timmia,* . . .		2		72,	8	Leskea, . . . .	3	5	
52,	4	Aulacomnium, . .	1	3	1	73,	1	Clasmatodon, . .	1		
53,	30	Bryum, . . . .	1†	29	4	74,	3	Thelia, . . . .	3		
54,	11	Mnium, . . . .	1	10		75,	1	Myurella, . . .	1		
55,	4	Meesia, . . . .		4		76,	5	Fabronia, . . .	4	1	
56,	1	Amblyodon,‡ . .		1		77,	1	Anacamptodon, .		1	
57,	1	Paludella, . . .		1		78,	3	Pylaisæa, . . .	3		
58,	7	Bartramia, . . .	1	6		79,	1	Homalothecium, .	1		
59,	1	Conostomum, . .		1		80,	1	Platygyrium, . .		1	
60,	4	Funaria, . . . .	1	3	2	81,	1	Pterigynandrum, .		1	1
61,	1	Enthostodon, . .	1			82,	6	Cylindrothecium, .	5	1	

\* *Timmia Austriaca* Hedw. and *Bryum Ludwigii* Spr. are new discoveries for our Bryologia. They were collected in 1862, on the Rocky Mountains near Pike's Peak by Mr. E. Hall.

† *Bryum Lescurii* Sul., the only Eastern North American species of this genus, is so nearly related to *Bryum carneum* L., that it might be considered by some bryologists as an American variety of it.

‡ *Amblyodon dealbatus* P. B. In the Rocky Mountains by Drummond. It was found also near Milwaukie (1862), by Mr. I. A. Lapham and myself.

§ *Physcomitrium tetragonum* Förn. was collected in very fine specimens by Mr. E. Hall in the plains of the Platte River.

Whole number of species in each genus.		Exclusively E. N. Amer.	Europe and E. N. Amer.	Also in California.	Whole number of species in each genus.		Exclusively E. N. Amer.	Europe and E. N. Amer.	Also in California.
No. 83, 3	Neckera, . . . .		3		No. 87, 106	Hypnum, . . . .	34	72	5
84, 3	Omalia, . . . .	2	1		88, 1	Pilotrichium, . .	1		
85, 1	Hookeria, . . . .	1			89, 1	Meteorium,* . . .	1		
86, 2	Climacium, . . . .	1	1		Total, 493		152	341	42

This table shows the four hundred and ninety-three species of Eastern North America, divided into eighty-nine genera, and distributed thus: one hundred and fifty-two species, or thirty and one-half per cent. belong exclusively to Eastern North America; three hundred and forty-one species or sixty-nine per cent. are common to Eastern North America and Europe, and only forty-two species or eight and one-half per cent. belong to Eastern North America, Europe, and Western North America. But to give a satisfactory view of the distribution of our North American mosses, this table must be completed by a similar one of the Californian species.

Whole number of species in Western North America.		Exclusively W. N. Amer.	Europe and W. N. Amer.	Whole number of species in Western North America.		Exclusively W. N. Amer.	Europe and W. N. Amer.
No. 1, 5	Phascum, . . . .		5	No. 11, 1	Tetraphis, . . . .		1
2, 2	Gymnostomum, . .		2	12, 1	Encalypta, . . . .		1
3, 2	Weisia, . . . .		2	13, 2	Pottia, . . . .		2
4, 1	Dicranum, . . . .		1	14, 1	Zygodon, . . . .	1	
5, 1	Ceratodon, . . . .		1	15, 5	Orthotrichum, . .	2	3
6, 1	Fissidens, . . . .	1		16, 2	Schistidium, . . .		2
7, 3	Trichostomum, . .	1†	2	17, 5	Grimmia, . . . .	1	4
8, 22	Barbula, . . . .	8	14	18, 1	Racomitrium, . . .		1
9, 2	Desmatodon, . . .		2	19, 1	Hedwigia, . . . .		1
10, 1	Anacalypta, . . . .		1	20, 1	Braunia, . . . .	1	

\* These last two genera, like Nos. 34, 38, 39, belong to a tropical flora. Other representatives of these may be found in Florida.

† Belonging to Kamtschatka also.

Whole number of species in Western North America.			Exclusively W. N. Amer.	Europe and W. N. Amer.	Whole number of species in Western North America.			Exclusively W. N. Amer.	Europe and W. N. Amer.
No. 21,	1	Atrichum, . . .		1	No. 30,	1	Physcomitrium, . .		1
22,	3	Polytrichum, . . .	1	2	31,	2	Pterogonium, . .		2
23,	1	Pogonatum, . . .	1		32,	2	Leskea, . . . .	1	1
24,	1	Aulacomnium, . .		1	33,	2	Alsia, . . . . .	2	
25,	11	Bryum, . . . .	4	7	34,	1	Neckera, . . . .	1	
26,	2	Mnium, . . . .	2		35,	1	Antitrichia, . . .	1	
27,	2	Bartramia, . . .	1	1	36,	1	Fabronia, . . . .		1
28,	3	Funaria, . . . .		3	37,	26	Hypnum, . . . .	15	11
29,	1	Enthostodon, . .	1		Total,	121		45 35 per cent.	76 62½ per ct.

Our first remark in looking over these tables, is on the scantiness of the Bryological Flora of California, and the small number of genera in which the species are distributed. *Sphagnum*, *Andræa*, *Campylopus*, *Didymodon*, *Meesia*, *Cryphæa*, *Leucodon*, *Anomodon*, *Thelia*, &c., have, every one of them, a number of representatives in Eastern North America and none in the West. This could be explained perhaps in supposing that we are still too little acquainted with the mosses of California, and that future researches may bring the discovery of a greater number of species. But from what we know of the climate of that State we must admit, I fear, that this scantiness of mosses is rather real than apparent. The vegetation of the mosses, as everybody knows, is particularly favored by a certain degree of constant humidity, and on the contrary, alternate changes of great humidity and dryness tend to destroy it. Now these last climatic conditions are especially marked in California. Professor William H. Brewer, of the Geological Survey of this State, in a very interesting letter on this subject to Mr. W. S. Sullivant, remarks, that the climate of California is particularly unfavorable to the vegetation of the mosses; that except a narrow strip near the coast, where the fog which comes in from the Pacific Ocean brings moisture, the supply of mosses is extremely limited. Everywhere east of the Coast Range, the climate is so very dry in summer, that no dew is deposited on cold nights. Even on mountains of greater altitude, he remarks the same absence of mosses. Professor Brewer ascended Mount Shasta (altitude 14,400 feet), in September, expecting to find there many Alpine mosses, but found none. Of the Coast Range, which, from its exposure to the fogs of the ocean, is apparently better adapted for the vegetation of the mosses, Mr. Bolander

has explored some parts, and he makes the same remarks about the scarcity of mosses. On Mount Diablo he found *Grimmia montana* and *Braunia* on dry rocks, and one or two species only at the bottom of deep cañons.

Now looking to the part of Europe to which the Bryologia of California is essentially related, viz., to the countries around the Mediterranean Sea, and inquiring into their climatic conditions as related to the vegetation of the mosses, we find them remarkably identical.

W. P. Schimper, the greatest of all past and present bryologists, went to Spain some years ago for the purpose of exploring and collecting the mosses of the mountains of that country, especially of the Sierra Nevada. He hoped to find there remarkable and new species, and expected a rich scientific result of his researches. He came back disappointed. The Sierra Nevada of Spain had scarcely any mosses; only those common species found everywhere on dry ground and dry rocks. The high summits of these mountains, covered part of the year by dense fogs, or drenched by diluvial rains, are in the summer entirely dry and barren. Everywhere, says the celebrated professor of Strasbourg, the naked rocks are exposed to view without any trace of those green carpets of *Sphagnum*, *Andræa*, *Gymnostomum*, *Weisia*, *Dicranum*, &c., &c., which cover the constantly-watered declivities of the Swiss Alps, of the Pyrenean, and especially of the Dovrefield Mountains of Norway. The same absence of mosses, due to the same climatic conditions, has been remarked also in the Caucasus by Mr. Dubois de Montperreux, and in Algeria by French botanists. All these countries are about on the latitude of California, and evidently we can trace to a similarity of mere climatic circumstances, the first cause of the extraordinary relation of the bryological vegetation.

The climate of Eastern North America has a greater degree of similarity with that of North and Middle Europe, and we find the same degree of relation in our mosses. We have especially in common the subalpine species, inhabiting the mountains of New York, of Massachusetts, even the summits of the Alleghany Mountains, and the plain near the northern lakes, exactly following the geographical distribution of the *Abies*. If this flora of ours is not quite as rich as that of Europe, the reasons are easily found, 1st. In the absence of a higher group of Alpine mountains, whose influence tends to enrich the vegetation of mountains of second order. 2d. In the predominance of forests in this country, where they cover the subalpine mountains nearly to their highest summits, preventing therefore the differences caused by a variety of habitat and of station. 3d. In the frequent conflagration of these forests, which tends to destroy in part the vegetation of the mosses, and of course to render it more uniform.

But there is still another cause of distribution of the mosses, by which we can explain, not only the relation of forms, but also the differences which characterize the Bryologia of

the North American continent. It is the adaptation of each species of moss to a peculiar habitat. These humble and apparently useless beings have their geological and lithological preferences far better marked than any other kind of vegetables. They select also to live upon, different species of trees, different substances, the dung of certain animals, the muddy deposits of a peculiar nature, the barren ground or the meadows inhabited by special grasses, old fences, old roofs, old mud walls, &c. This explains, 1st. Why, according to the tables of distribution, the mosses living on the ground, *Gymnostomum*, *Weisia*, *Barbula*, *Desmatodon*, *Trichostomum*, &c., are generally identical in Europe and on both sides of the North American continent, varying only according to climatic influences; and also why, when we come to species living on the bark of trees, or to peculiar substances, the specific and even the generic differences are manifest. Thus we find in Eastern North America, all the species of *Drummondia*, *Ptychomitrium*, *Cryphæa*, *Leucodon*, *Leptodon*, *Clasmatodon*, *Thelia*, *Homalothecium*, *Pylaisæa*, and in Western North America, *Alsia*, exclusively arboreal and exclusively indigenous, most of these genera having not even any specific representative in Europe. In other genera, like *Orthotrichum*, *Anomodon*, *Leskea*, *Cylindrothecium*, *Climacium*, *Hypnum*, we find equally identity or near affinity of forms for the species living on the ground, or on rotten, decomposed substances already nearly transformed into humus, while we have generally specific differences for the truly arboreal species.

There are indeed exceptional cases, apparently tending to weaken the prevalence of this rule. But I think that they might be easily explained if we were well acquainted with the true nature of the substances supporting mosses, and with the local influences which may act sometimes on their distribution. To exemplify this assertion, we may examine a few of those apparent exceptions. All the species of the genus *Sphagnum* live in bogs, and their existence is apparently depending on water only. We have, nevertheless, in Eastern North America, eight species different from those of Europe. But the water of the bogs where these mosses\* are generally living is more or less impregnated with ulmic acid, resulting from the decomposition of wood, and there may be accordingly some chemical influence acting on the distribution of the species. Moreover, most of the exclusively American species of this genus belong to a warmer climate, or to a parallel of latitude where in Europe the destruction or the scarcity of the forests has prevented the formation of bogs. We have only two indigenous species: *Sphagnum cyclophyllum* Sul. & Lesq. and *Sphagnum sedoides* Brid., with a northern range of distribution. They live either on the sand, or on granitic rocks, covered with water part of the year and en-

\* According to Professor Schimper, the genus *Sphagnum* does not belong to the mosses, but to a separate family, the plants having a thallus like the Lichenes, and a conformation of their own.

tirely dry in summer. Hence, they periodically disappear, being apparently renewed each year from their thallus, and never reaching their entire development. They bear simple short stems, scarcely branching, and have never been found in fruit. It is evident that their presence, if not their form, is due to peculiar and local circumstances.

In the *Phascaceæ*, we have in Eastern North America five exclusively indigenous species of *Bruchia*. A single species of this genus has been found once only in the Vosges Mountains of Europe, at an altitude corresponding with that of the summit of Mount Marcy (about 6000 feet), on the decomposed dung of cows. Our *Bruchia flexuosa* Schw., whose habitat I had opportunity to closely examine, is found in the spring in large round patches, apparently on the naked clay ground, but really at such places which were formerly covered by the dung of animals feeding in the meadows. The southern species have probably a habitat of the same kind, being found along the canals on the sand of the tow-paths. If this is the case, the distribution of these mosses is according to the general rule. The dung in various climatic conditions is the local habitation of different species of mosses. Our only true American *Splachnea*, *Tetraplodon Australis* Sul. & Lesq., lives in the Southern swamps on the dung of mules.

The *Fontinales* are always found in water. The number of true American species, either on the east or on the west side of the continent, is pretty large, most of the species being truly arboreous. Indeed, they attach themselves to branches and roots of trees plunging in water, and occasionally only to stone. The few species which may be called *rock* species, generally attached to stones, like *Fontinalis Dalecarlica* Bryol. Eur., are found both in Europe and in Eastern North America.

The genus *Dicranum* shows apparently another kind of anomaly of distribution, that is, identity of forms and variety of habitat. Twenty-seven of our Eastern North American species are the same as in Europe, though some of them are truly arboreous. All the arboreous ones live on rotten or decayed wood in the spruce region. The other species are mostly inhabiting the stones or the ground in the subalpine region, or the bogs. Their distribution is thus according to the common rule.

The affinity and also the modifications of forms following the influence of habitat, are better marked perhaps in the distribution of the genus *Orthotrichum* than in any other. The species living on rocks, *Orthotrichum Sturmii* Hpp., *O. anomalum* Hedw., *O. cupulatum* Hoff., *O. Hutschinsiae* Grev., and also the subalpine arboreous species living on the bark of the spruce and the beech, *Orthotrichum Rogeri* Brid., *O. speciosum* Nees., *O. leiocarpum* Br. & Schp., *O. Ludwigii* Schw., *O. crispulum* Hrsch., are identical in Europe and Eastern North America. On the contrary, the true arboreous species of the plain or of the temperate zone, *Orthotrichum exiguum* Sul., *O. Texanum* Sul., *O. strangulatum* Beauv., *O. Canadense* Br. & Schp., are exclusively indigenous. One of our *Orthotricha*-



ceæ only, considered as a variety of *Orthotrichum Lyellii*, seems to have an exceptional distribution, inhabiting as it does the bark of trees of the temperate zone. This would perhaps prove that this variety, as Hampe will have it, is a true American species. The name of *O. papillosum* Hmp. is well adapted to it.

It would appear that there is in the composition of some stones, peculiar substances which may affect the distribution of the mosses. Two Eastern North American species of *Desmatodon* live, one exclusively on conglomerate sandstone, the other on old bricks. Our indigenous species of small *Fissidens* are found also near the water on sandstone, either rolled in the creeks or cut for constructions, except *Fissidens subbasilaris* Hedw., a true arboreal species.

It is perhaps to this predilection of some mosses for a peculiar kind of stone, that we owe in our temperate climate the presence of *Eustichium Norvegicum* Bryol. Eur., inhabiting the conglomerate sandstone of Southern Ohio and Southern Kentucky, and considered by European bryologists as an exclusively northern species.

We might perhaps look for a third cause influencing the geographical distribution of the mosses, in the peculiar tendency of nature of associating in the same region similar forms, nearly allied species or may be varieties. Whatever might be the manner of explaining this grouping, it exists for the mosses far more evidently than for the phænogamous plants. Thus we have here, three species of *Cryphæa*, two of *Leucodon*, three of *Leptodon*, seven of *Anomodon*, three of *Thelia*, three of *Pylaisæa*, six of *Cylindrothecium*, and a great number of *Hypnum*, &c., whose specific characters are sometimes blended together in a way truly perplexing for the examiner. Even these specific differences can be sometimes followed on plants living in close proximity, and their cause apparently traced to natural variations of habitat. The *Thelia* live generally attached to the smooth bark at the base of both *Carpinus Americana* Mich. and *Ostrya Virginica* Willd. Now *Thelia hirtella* Sul., with simple papillæ on the back of the leaves, is found higher on the trunk. When it descends on the uncovered roots and becomes more exposed to the sun, the color is grayish, the papillæ are bilobed at the apex, there is a difference in the peristome, and we have indeed another species, *Thelia asprella* Sul. Southward, in Kentucky and Tennessee, this *Thelia asprella* is seen sometimes attached to small roots plunging in the sand. From the roots, the moss itself passes to the sand, becomes fixed to the ground, is now different in some characters, areolation and peristome, and a third species, indeed, *Thelia Lescurii* Sul., apparently due to the influence of another habitat. Such imperceptible changes of forms corresponding with progressive variations, might be followed in the same manner, in other genera, especially in the species of the genus *Cylindrothecium*. But this examination would be now of small value; for without long and experimental researches, our belief in the influence of external circumstances of habitat on the form, can be but merely conjectural.